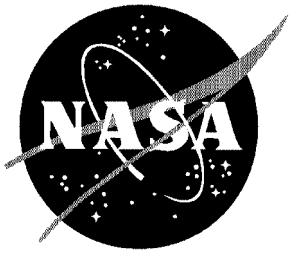

National Aeronautics and Space Administration

APRIL 13, 2001
NRA 01-OSS-03

RESEARCH ANNOUNCEMENT

KECK INTERFEROMETER COMMISSIONING TEAM SCIENCE

Notice of Intent Due: **MAY 14, 2001**
Proposals Due: **JUNE 29, 2001**

OMB APPROVAL NO. 2700-0087

KECK INTERFEROMETER COMMISSIONING TEAM SCIENCE

NASA Research Announcement
Soliciting Basic Research Proposals

NRA 01-OSS-03
Issued: April 13, 2001

Proposals Due
June 29, 2001.

Office of Space Science
National Aeronautics and Space Administration
Washington, DC 20546-0001

KECK INTERFEROMETER COMMISSIONING TEAM SCIENCE

SUMMARY OF SOLICITATION

- INTRODUCTION

The stated mission of the Space Science Enterprise of the National Aeronautics and Space Administration (NASA) is to solve the mysteries of the universe, to explore the solar system, to discover planets around other stars, and to search for life beyond Earth. To carry out this mission, NASA's Office of Space Science (OSS) sponsors a broad range of research programs relevant to its four Science Themes, one of which is called the *Astronomical Search for Origins and Planetary Systems* (ASO) that addresses the origins of galaxies, stars, proto-planetary and extra-solar planetary systems, Earth-like planets, and the origin of life (further information about all of the OSS themes may be found through the OSS homepage on the World Wide Web at http://spacescience.nasa.gov). In particular, this NASA Research Announcement (NRA) solicits proposals in support of the ASO theme through the initial use of the Keck Interferometer facility that NASA jointly funds in cooperation with the Jet Propulsion Laboratory and the W. M. Keck Observatory that is managed by the California Association for Research in Astronomy (CARA).

Specifically, the Office of Space Science solicits proposals for scientific investigations with the Keck Interferometer in its initial phase of single-baseline interferometry with the two Keck telescopes. This solicitation invites proposals in two specific areas: development phase science in Differential Phase and Nulling and Shared Risk Fringe Visibility Science. The successful investigators chosen through this solicitation will partner with the Keck Interferometer Development Team as members of the Keck Interferometer Commissioning Team to participate in any early science that may result from observations obtained during the commissioning of the interferometer. The details of the objectives of this NRA in these two areas are given in Appendix A and references therein.

Approximately $250K will be available each year to fund up to four proposals for durations of up to two years. Roughly half of NASA's approximately 84 nights per year on the Keck telescopes will be made available for commissioning of the interferometer in the next two years. It is expected that some part of the NASA commissioning time will be used for implementation of the investigations selected by this solicitation.

In all cases, the Government's obligation to make awards is contingent upon the availability of appropriated funds from which payment can be made and upon the receipt of proposals in response to this NRA that NASA determines are acceptable for award. Participation in this program is open to all categories of U.S. and non-U.S. organizations, including educational institutions, industry, nonprofit organizations, NASA Centers, and other Government agencies. Historically Black Colleges and Universities (HBCU's),

other minority educational institutions, and small businesses and organizations owned and controlled by socially and economically disadvantaged individuals or women are particularly encouraged to apply. Participation by non-U.S. organizations in this program is encouraged subject to NASA's policy of no-exchange-of-funds (see further information in the "*OSS Guidebook for Proposers…*" discussed below).

• NEW INSTRUCTIONS FOR PREPARATION/SUBMISSION OF PROPOSALS

Starting in 1998, the Office of Space Science began to use a single, unified set of instructions for the submission of proposals for almost all of its NRA's that were incorporated into each NRA. Such standardization has proven to be of significant value to NASA to help ensure the uniform handling and processing of submitted proposals. However, starting in January 2001, these proposal policies and procedures, as well as those for NASA's review and selection of proposals for funding, are now described in a separate document entitled "*Office of Space Science (OSS) Guidebook for Proposers Responding to NASA Research Announcement – January 2001*" (abbreviated as "*OSS Guidebook – 2001*") that is accessible by opening "*Research Opportunities and Data*" from the menu at the World Wide Web URL http://spacescience.nasa.gov or may be directly accessed at URL http://spacescience.nasa.gov/research/ossguidebook.

By reference, *OSS Guidebook – 2001* is hereby incorporated into this NRA, and proposers to this NRA are responsible for understanding and complying with its procedures before preparing and submitting their proposals. In particular, Chapter 2 ("Proposal Preparation and Organization") and Chapter 3 ("Proposal Submission Procedures") largely replace the contents of "Appendix C" in most OSS NRA's issued during the previous three years. Proposers familiar with these recent OSS NRA's will find that these instructions are essentially unchanged from those introduced starting in 1998, although the material is rearranged somewhat. Also, note that the NASA-required proposal *Budget Summary* form is now available electronically through the Web site designated for the *Cover Page/Proposal Summary* (see Summary Information below) for printing in hard copy for submission with the hard copies of the proposal. The other chapters and appendices of *OSS Guidebook – 2001* provide supplemental information about the entire NRA process, including NASA policies for the solicitation of proposals (including those involving non-U.S. participation), guidelines for writing complete and effective proposals, the NASA policies and procedures for the proposal review and selection processes and for issuing and managing the awards to the institutions that submitted selected proposals, and Frequently Asked Questions (FAQ's) about a variety of proposal and award processes and activities.

Comments and suggestions of any nature about *OSS Guidebook – 2001* are encouraged and welcomed and may be directed at any time to Dr. David Bohlin, Research Program Management Division, Code SR, Office of Space Science, NASA Headquarters, Washington, DC 20548; telephone: 202/358-0880; E-mail: david.bohlin@hq.nasa.gov (if submitted by E-mail, use "Proposer's Guidebook" without quotations as the Subject of the message).

• OSS EDUCATION AND PUBLIC OUTREACH (E/PO) PROGRAM

OSS policy continues to strongly encourage participation by the space science community in education and public outreach activities with the goal of enhancing the Nation's formal education system and contributing to the broad public understanding of science, mathematics, and technology. A significant national program in space science education and outreach is now underway, and OSS's demonstrated contributions to education and outreach have now become an important part of the broader justification for the public support of space science (for further details open "*Education and Public Outreach*" on the OSS homepage at http://spacescience.nasa.gov).

Since 1998, when it started to offer the opportunity to propose E/PO activities in conjunction with its NRA's, the Office of Space Science has received many constructive comments from members of the space science community as to how to improve its efforts to involve space scientists in education and public outreach. Based on the experience of the past few years and these comments, OSS is making a number of important changes in procedure this year. In particular, for OSS NRA's released starting in January 2001, E/PO proposals for additional funding for this activity will be solicited only from those proposers whose research proposals have been already selected for an award. This change should decrease the overall workload on the space science community, increase the likelihood that more E/PO proposals of merit will be funded, and more effectively encourage successful science proposers to add an E/PO component to their research effort.

Therefore, only those proposers to this NRA who are eventually selected on the basis of the excellence of their research awards will be eligible to propose a supplemental E/PO program in accord with the OSS E/PO policies and guidelines. At the time of the release of this NRA, it is currently planned that selected Principal Investigators will have two windows of opportunity to submit an E/PO proposal, either: (i) no later than 45 days after the date of the letter of selection of their parent research proposal, with the anticipation of starting the proposed E/PO activity within the first third of the first year of the parent research award; or (ii) no later than 75 days before the yearly anniversary date of their award, with the anticipation of starting the proposed E/PO activity in conjunction with next yearly funding supplement of their multiple year award. In either case, consistent with the past E/PO policies and to ease the burden of NASA's administration of these supplemental awards, the total period of performance of an E/PO award will be restricted to that of its parent research award.

The current description of the underlying strategy and implementation plans for the OSS E/PO program may be found through the menu item *Education and Public Outreach* on the OSS homepage at http://spacescience.nasa.gov. The specific policies and procedures for writing and submitting supplemental E/PO proposals in conjunction with proposals selected through this NRA will be posted no later than the end of July 2001, which will be sufficiently early to allow those selected to organize and submit an E/PO proposal.

Questions and/or comments about this OSS E/PO program are sincerely welcomed and may be directed to Dr. David Bohlin, Research Program Management Division, Code SR, Office of Space Science, NASA Headquarters, Washington, DC 20546 (telephone: 202-358-0880; E-mail: david.bohlin@hq.nasa.gov)

• ITEMS OF SPECIAL IMPORTANCE

(1) OSS now requires the electronic submission of certain key elements of proposals through the World Wide Web (see below in the Summary Information), and this practice continues with this NRA. While every effort is made to ensure the reliability and ease of accessibility of this Web site, and to maintain a point of contact for assistance via E-mail, difficulty in accessing and/or using this site may arise at any point on the Internet including the user's own equipment. Therefore, prospective proposers are urged to familiarize themselves with this site and to submit the required proposal materials well in advance of the deadline(s) of the program element(s) of interest.

(2) OSS maintains an electronic notification system to alert interested subscribers of the impending release of its research program announcements. Subscription to this service is accomplished through the menu item *Get E-mail Announcements* on the OSS home page at http://spacescience.nasa.gov by following the instructions for *Space Science Research Announcements*. Owing to the increasingly multidisciplinary nature of OSS programs, this electronic service will notify subscribers of all future NASA OSS program announcements regardless of its type and objective (10 to 15 per year). Regardless of whether this service is subscribed to or not, all OSS research announcements may be accessed from the Web as soon as they are posted (about 8:30 a.m. Eastern Time on the day of release) through *Research Opportunities and Data* on the OSS homepage.

• SUMMARY INFORMATION APPLICABLE TO THIS NRA

• Program alphanumeric identifier: NRA 01-OSS-03

• Date of NRA issue: April 13, 2001

• Guidance for preparation and submission of proposals:

"*OSS Guidebook for Proposers – 2001*" at URL
http://spacescience.nasa.gov/research/ossguidebook/

• Submission of *Notice of Intent* (NOI) to propose:

- Due date: May 14, 2001

- Web site for electronic submission: http://props.oss.hq.nasa.gov
(contact for help: deb.tripp@hq.nasa.gov)

- Electronic submission of the proposal's *Cover Page/Proposal Summary*:

  - Deadline: 5 p.m. Eastern Time on June 29, 2001

  - Web site for electronic submission: http://props.oss.hq.nasa.gov
    (contact for help: deb.tripp@hq.nasa.gov)

- Web site for access to proposal Budget Summary form and Budget Instructions:

  http://props.oss.hq.nasa.gov
  (contact for help: deb.tripp@hq.nasa.gov)

- Submission of hard copy of proposals:

  - Page limits: See Section 2.3 of "*OSS Guidebook for Proposers – 2001*" for default values.

  - Required number: Signed original plus 15 copies.

  - Deadlines: 5 p.m. Eastern Time on June 29, 2001

- Address for submission by US Postal Service, commercial delivery, or courier:

  Keck Commissioning NRA
  NASA Peer Review Office
  Suite 200
  500 E Street, SW
  Washington, DC 20024
  Telephone: 202/479-9030

- Selecting Official: Director or Deputy Director
  Research Program Management Division
  Office of Space Science

- Announcement of selections: Goal: 150 days after proposal due date.

- Initiation of funding for new awards: Goal: 46 days after proposal selection.

- Further information –

  - Specific science program elements:

Dr. Philippe Crane
Research Program Management Division
Code SR
Office of Space Science
National Aeronautics and Space Administration
Washington, DC 20546-0001
Phone: (202) 358-0377
E-mail: philippe.crane@hq.nasa.gov

  - General NRA policies and procedures:

Dr. David Bohlin
Research Program Management Division
Code SR
Office of Space Science
National Aeronautics and Space Administration
Washington, DC 20546-0001
Phone: (202) 358-0880
E-mail: david.bohlin@hq.nasa.gov

The Keck Interferometer represents an exciting new observing capability for the advancement of the NASA OSS Origins science theme. Your interest and cooperation in responding to this NRA are appreciated.

Anne L. Kinney
Science Program Director
Astronomical Search for Origins
and Planetary Systems

APPENDIX A

DESCRIPTION OF RESEARCH OPPORTUNITY

1.0 Scope of Program

1.1 Introduction

This NRA solicits proposals of scientific investigations utilizing the Keck Interferometer in its initial phase as a single-baseline interferometer with the two Keck telescopes, and in collaboration with the Keck Interferometer Project Team at the Jet Propulsion Laboratory (JPL) and the W. M. Keck Observatory that is managed by the California Association for Research in Astronomy (CARA). The Keck Interferometer, which is funded by NASA as a joint development between JPL and CARA, will combine the two 10-meter (m) Keck telescopes with four 1.8-m "outrigger" telescopes as an interferometer array capable of addressing a broad range of astronomical science. The Keck Interferometer is designated as a ground-based component of the NASA Office of Space Science (OSS) theme called the Astronomical Search for Origins and Planetary Systems that addresses fundamental questions about the formation of galaxies, stars, and planetary systems, the prevalence of planetary systems around other stars, and the formation of life on Earth.

The Keck Interferometer has five modes of operation, namely:

- Measurement of fringe visibility (e.g., diameters of stars or other sources),
- Multicolor differential phase measurements (high dynamic range imaging),
- Nulling (at 10 micron only),
- Precision astrometry, and
- Six-telescope imaging.

This solicitation invites proposals for scientific investigations that will utilize only the first three of these observing modes. In each mode, selected investigators are expected to work with the Keck Interferometer project personnel to help develop the scientific capabilities of this new facility. Since the performance of the instrumentation cannot be guaranteed, there is some significant chance that the selected observations cannot be obtained. Nevertheless, NASA is soliciting scientific investigations at this stage to ensure that early science opportunities are available to the community to the maximum extent possible and to involve the community in the development of this exciting new facility.

Proposers to this NRA should be aware of the following two potential limitations for the execution of a proposed investigation at this time:

- It is anticipated that the Fringe Visibility mode of the Keck Interferometer will be substantially verified by the time science investigations selected in response to this NRA will be implemented (target: October 2001). Therefore, investigations utilizing

this mode will be conducted in a so-called “Shared Risk” mode explained in Section 1.3 below.

- Science investigations utilizing the Differential Phase and the Nulling “extreme accuracy” modes of the interferometer cannot expect to be executed with a guaranteed level of performance for the instrument since the verification of these modes is only expected to begin about the time that the investigations selected through this NRA can be implemented. Therefore, the science investigations proposed to be performed in these two modes is referred to as “Development Science,” and the details of how investigations selected for this mode will be accommodated are explained in Section 1.4 below.

Proposals may be for either shared risk science, development phase science, or both. Proposals should contain a precise description of the scientific goals, as well as a generic list of potential targets.

1.2 Technical Description of the Keck Interferometer

The Keck Interferometer will use Michelson beam combination among the two Kecks and the four outriggers (a full description of the Keck Interferometer can be found at http://huey.jpl.nasa.gov/). The two Kecks provide a baseline of 85 m, while the baselines available with the outriggers will be between 30 m and 135 m. The interferometer will combine phased pupils provided by adaptive optics on the Kecks and fast tip/tilt correction on the outriggers. Co-phasing of the array will be accomplished by fringe tracking on an isoplanatic reference to enable high-sensitivity science observations. Key components of the co-phasing system include active delay lines in the beam-combining laboratory and dual-star modules at each telescope. Several back-end beam combiners will eventually be available, including two-way beam combiners at 1.5-2.4 microns for fringe tracking, astrometry, and imaging; a multiway combiner at 1.5-5 microns for imaging; and a nulling combiner for high dynamic range observations at 10 microns.

The Keck Interferometer will be brought into operation in stages. The first stage, involving fringes with two 50 cm siderostats, has been achieved in February 2001. First fringes with the two 10 meter telescopes was achieved on March 12, 2001. The installation and commissioning of the outrigger telescopes is expected to begin in late 2001 or 2002. The Development Phase and Shared Risk science solicited through this NRA (see Section 1.1 above) is expected to begin around October 2001.

The Keck Interferometer has several "extreme accuracy" modes of operation (nulling and multicolor differential phase are addressed here) whose implementation will require several iterations of observations, data analysis, problem diagnosis, and changes to the instrument. Therefore, the most ambitious observations will be possible only after extensive verification of the ensemble of components during the observations of real science targets. In order to make most efficient use of the Keck telescope time, much of the observing time for the interferometer commissioning will be allocated in 1/2-night increments.

1.3 Proposals for "Shared Risk" Science

The first measurement mode to be verified and, therefore, expected to be operational by the time investigations selected in response to this NRA can be implemented, is that of fringe visibility. Potential proposers are directed to the Keck Interferometer Web site for a description of the capabilities and limitations of visibility measurements with the two 10 m telescopes.

Successful proposals to use the fringe visibility capabilities of the Keck Interferometer will be implemented in the shared risk science program. Shared risk opportunities will be available as "backup" science, as well as through specifically allocated time as described below.

During the process of commissioning the extreme accuracy modes of the interferometer, there may be instances where a problem in one of these modes is identified that cannot be fixed that same night. When possible in such a case, the instrument will be switched to a verified mode of operation, e.g., fringe visibility. Therefore, NASA wishes to have a reserve set of backup science observations that can be conducted to make the most efficient use of the Keck telescope time.

In addition, while commissioning of the interferometer and its associated instruments will have the highest priority, NASA anticipates that a fraction of the time allocated to the Keck Interferometer will be specifically reserved for shared risk fringe visibility science activities covered by this NRA in the course of three observing semesters (2001B, 2002A, and 2002B, where A and B denote semesters beginning in February and August of the year, respectively). When making shared risk observations, the Keck Interferometer will operate in queue mode, with targets programmed for automatic observation as time, weather, etc. permit.

Due to the essentially experimental nature of this opportunity, the successful proposers will partner with the Keck Interferometer Development team as members of the Keck Interferometer Commissioning Team under the lead of the Keck Interferometer Project Scientist to implement any scientific investigations. It is NASA's expectation that this team consisting of the successful investigators and the Keck Interferometer Development Team will jointly define the observing program and will jointly be involved in specifying targets, obtaining and analyzing the data, and in publishing the results. In particular, the successful respondents to this section of the NRA are expected to interact with all parts of the Keck Interferometer Development team; with JPL and CARA concerning detailed instrumental matters; and with the Interferometer Science Center (ISC) and CARA concerning science scheduling, data archiving and data product access, and analysis matters.

1.4 Proposals for "Development Phase" Science

Development Phase Science refers to science observations that are obtained in the process of verifying the Keck Interferometer's extreme accuracy modes of operation,

namely, those that acquire data through differential phase and nulling. The motivation behind soliciting science investigations for this phase of the interferometer development is to involve the community in the development of the facility by actually trying to take science data as early as possible.

Proposers for Development Phase Science should propose science programs that can make use a range of instrument performance, and, in particular, should design a science program that could produce useful science even if the instrument does not meet its ultimate performance goals. For example, while the final goal for the nulling mode is to be able to detect zodiacal dust around a nearby star at roughly 10 times the level of the solar system zodi, initial operation of the nuller is not expected to be that precise. Therefore, proposers should strive to design a science program that can both be used to verify and tune the interferometer mode, as well as produce science before the full accuracy of the instrument is achieved.

Due to the essentially experimental nature of this opportunity, the successful proposers will partner with the Keck Interferometer Development team as members of the Keck Interferometer Commissioning Team under the lead of the Keck Interferometer Project Scientist to implement any scientific investigations. It is NASA's expectation that this team, consisting of the successful PI's and the Keck Interferometer Development Team, will jointly define the observing program and will jointly be involved in specifying targets, obtaining and analyzing the data, and in publishing the results. In particular, the successful respondents to this section of the NRA are expected to interact with all parts of the Keck Interferometer Development team; with JPL and CARA concerning detailed instrumental matters; and with the Interferometer Science Center (ISC) and CARA concerning science scheduling, data archiving and data product access, and analysis matters.

It is anticipated that any observations obtained as development phase science will occur in the course of the observing period beginning with semester 2001B and extending through the observing period 2002B which ends in February 2003.

2. Programmatic Considerations

The Keck Interferometer is designed to extend our knowledge into the formation of stars and planets, take an inventory of planets in the solar neighborhood, and provide NASA with data on the prevalence of zodiacal dust in nearby stars. This dust might interfere with the detection of Earthlike planets by future NASA space missions. While these topics are specifically solicited by this NRA, because of the development phase and shared risk nature of this NRA, science topics other than the narrow "origins/planets" field are also encouraged as long, as the observations are technically feasible and the expected results are scientifically compelling.

Potential respondents to this NRA should recognize that NASA is making this solicitation for a facility that is in development and expects that respondents will contribute to this development. Therefore, respondents should include a section in their response indicating

how they would contribute to the further development of the operations of the Keck Interferometer, for example, in the area of algorithms and calibration techniques, or other areas of technical expertise.

Because the Keck Interferometer will still be in development during the period covered by this solicitation, there is no guarantee that any particular selected science investigation will be executed. Nevertheless, successful investigators will participate in the observing program of the Keck Interferometer Commissioning Science Team under the leadership of the Keck Interferometer Project Scientist. NASA does expect that significant observational data will be obtained during the commissioning period and the purpose of this solicitation is to involve the community as members of the Keck Interferometer Commissioning Science Team in the resulting science to the extent possible.

Recommendations for funding for the proposals submitted to this NRA will be based on the peer evaluation of each proposal measured against the criteria given in Section C.2 of Appendix C of the OSS Guide Book for Proposers.

Approximately $250K per year is expected to be available to fund up to four proposals for a period of up to two years beginning in about October 2001. NASA expects to schedule approximately half of its allocated 42 single telescope nights per semester for observations with or commissioning of the Keck Interferometer. Therefore, there will be approximately 10 Keck-Keck interferometer nights available per semester that will be allocated among instrument engineering, shared risk science, and development phase science.